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published in

Patient Education and Counseling
2002

DOI (link to publisher)

[10.1016/S0738-3991\(01\)00195-1](https://doi.org/10.1016/S0738-3991(01)00195-1)

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

van Es, S. M., Kaptein, A. A., Bezemer, P. D., Nagelkerke, A. F., Colland, V. T., & Bouter, L. M. (2002). Predicting adherence to prophylactic medication in adolescents with asthma: an application of the ASE-model. *Patient Education and Counseling*, 47(2), 165-171. [https://doi.org/10.1016/S0738-3991\(01\)00195-1](https://doi.org/10.1016/S0738-3991(01)00195-1)

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Predicting adherence to prophylactic medication in adolescents with asthma: an application of the ASE-model

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Received 25 April 2001; received in revised form 7 July 2001; accepted 24 September 2001

Abstract

An explanatory framework, referred to as the attitude/social influence/self-efficacy-model (ASE-model), was utilised to explain future self-reported adherence of adolescents to daily inhaled prophylactic asthma medication. The objective was to investigate the long-term influence of these earlier reported cognitive variables and other psychological and medical determinants on self-reported adherence 1 year later. Data were collected, via a questionnaire, from 86 adolescents with asthma (aged 11 through 18 years) recruited from outpatient clinics. Adherence was assessed by asking the patients to give themselves a report mark for adherence. The results of the multiple regression analyses showed that the three major ASE-variables were predictors of self-reported adherence to a moderate degree ($R^2 = 0.21$). Previous self-reported adherence was found to be the best predictor of self-reported adherence to prophylactic asthma medication 1 year later ($R^2 = 0.45$). The results of this study could be useful in the development of interventions to enhance adherence to asthma medication. In future, such interventions should focus on feelings of shame about having asthma and promoting healthy habits, such as adherence to medication. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Adherence; Adolescents; Attitude/social influence/efficacy-model (ASE-model); Asthma

1. Introduction

Asthma is a chronic inflammatory disorder of the airways, which causes recurrent episodes of wheezing, breathlessness, tightness of the chest, and coughing, particularly at night and/or in the morning. These symptoms are usually associated with widespread, but variable airway limitation that is at least partly reversible, either spontaneously or with treatment [1]. Patients with more than a mild form of asthma require treatment involving daily inhalation of prophylactic asthma medication (corticosteroids, cromones) to prevent and reverse this airway inflammation [1]. In addition, bronchodilatory drugs are indicated when patients suffer from asthma symptoms.

Patients with asthma can adopt a range of behaviour patterns themselves in order to manage their disease. Adherence to the prescribed medication is an important aspect of

the self-management of asthma; nevertheless, non-adherence to prophylactic medication is common, and may have serious consequences. In a study investigating the causes of death among adolescents with asthma, the authors concluded that poor adherence played a substantial role [2].

Self-reporting is the most commonly used method in the assessment of adherence to asthma medication [3,4]. Dekker et al. [5] found a mean of 8 for self-reported adherence on a scale of 0 to 10 in adolescents and adults with asthma. Adherence can also be defined as the percentage of prescribed doses actually taken. Reported degrees of adherence to inhaled prophylactic medication in children and adolescents with asthma vary between 30% [6] and 58% [7]. Various determinants of adherence have been described: the quality of the doctor–patient relationship [8–10], the complexity of the treatment regimen [9–11], feelings of shame about having asthma [12], severity of the asthma, demographical factors, such as sex and ethnic origin [10,13], and age, for which adolescence in particular is a negative factor [14].

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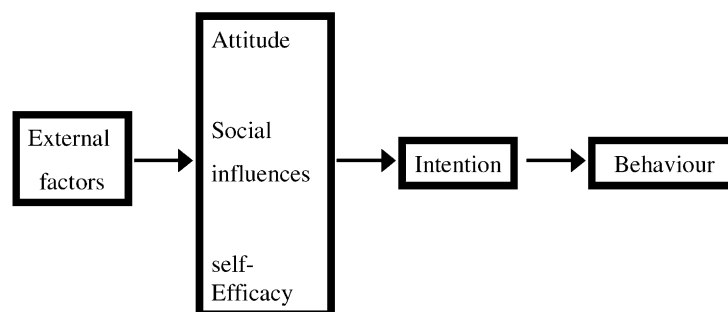


Fig. 1. ASE-model.

A potentially informative model which can be used to describe the determinants of adherence among adolescents with asthma is the Attitudes, Social influences and self-Efficacy (ASE-model) [15,16] (Fig. 1). This model has been successfully applied in several studies to explain various aspects of health behaviour, such as fruit and vegetable consumption [17,18], fat intake [19], the use of sunbeds [20], participation in employee fitness programs [21], smoking [16,22,23] and adherence to hormone replacement therapy [24]. The ASE-model originated from the theory of reasoned action (TRA) [25,26]. A new dimension, namely Bandura's concept of self-efficacy, has been added to the TRA concepts to form the ASE-model [15]. In the ASE-model, it is assumed that intention and subsequent behaviour are primarily determined by the following cognitive variables: attitudes, social influences, and self-efficacy expectations. Moreover, the model postulates that intention predicts subsequent behaviour. A person's attitude towards a specific behaviour (e.g. inhaling asthma medication) is a result of the consequences that a person expects from performing the behaviour (e.g. "inhaling medication will make me fat"). Social influences can be described as the processes whereby people directly or indirectly influence the thoughts, feelings, and action of others. Self-efficacy expectations pertain to a person's belief in his or her ability to perform the desired behaviour [17].

Cross-sectional analyses [27] indicated that the three major ASE-variables were moderately strong predictors of self-reported adherence to prophylactic asthma medication in adolescents. In particular, negative self-efficacy expectations and the intention to adhere appeared to be related to self-reported adherence. External factors did not contribute significantly to the prediction of adherence. However, only longitudinal research offers the opportunity to investigate the long-term influence of cognitive variables on adherence.

The present study investigates the degree to which the following cognitive variables: attitudes, social influences, self-efficacy expectations and intention can be used to predict self-reported adherence to prophylactic asthma medication 1 year later in adolescents. In response to the suggestion that previous behaviour will have no substantial unique contribution in predicting behaviour after controlling for attitude, social influences, self-efficacy, and intention

[28], self-reported adherence at baseline was also included to test this theory.

2. Methods

2.1. Respondents and procedure

Patients were recruited from six paediatric outpatient clinics. Two of these outpatient clinics were in academic teaching hospitals, one was in a specialised asthma centre, and the other three were in district hospitals. The criteria for inclusion were: asthma diagnosed by a physician; treatment prescribed by a paediatrician with daily inhalation of prophylactic asthma medication during a preceding period of at least 2 months; aged from 11 through 18 years; attending secondary school; ability to fill in a questionnaire in the Dutch language. Patients who met the inclusion criteria were informed about the study by their paediatrician, and both the patient and the parent(s) received written information regarding the study. Patients had at least 24 h to decide on whether or not they were willing to participate. The study protocol was approved by the Ethical Review Board of each participating centre, and all participants and their parents gave informed consent. Participants took part in a randomised controlled intervention study aimed at enhancing adherence in adolescents with asthma. They were randomly allocated to either the intervention program or to usual care by their paediatrician.

2.2. Measurements

Data were collected at baseline (T_0) and after 12 months follow-up (T_1). The participants filled in questionnaires which were based on the concepts of the ASE-model and other psychological, medical and demographical determinants. The paediatricians filled in a form on which they were asked to provide medical data. Details regarding these variables will be described in the following sections.

Cronbach's α coefficients of internal consistency were calculated for variables constructed by the summation of items scores at baseline; only those with coefficients >0.60 were selected for further analysis.

2.3. Dependent variable

Adherence was assessed at baseline and after 12 months follow-up by means of self-reports. Participants were asked to score their adherence on a 10-point scale (range: 1 = never take prophylactic medication to 10 = always take prophylactic medication, as prescribed).

2.4. Psychological determinants (ASE)

The ASE-variables were operationalised in several questions, and for each variable a sum-score was calculated. The questions were based on the results of a number of qualitative pilot studies concerning the attitudes, social influences and self-efficacy expectations of adolescents with asthma [29]. The concept of attitude was sub-divided into two scales: a positive and a negative attitude to taking medication. The concept of self-efficacy expectations was also sub-divided into two scales: self-efficacy directed at displaying the desired behaviour, and self-efficacy aimed at overdosing.

Positive attitude (pro) was based on three questions about one statement, involving three different 7-point scales (A: 1 = 'very good' to 7 = 'very bad'; B: 1 = 'very wise' to 7 = 'very foolish'; C: 1 = 'very harmless' to 7 = 'very damaging'). Participants were asked whether they agreed with the following statement: "If I took my asthma medicine every day that would be: ...". Sum-scores were obtained after reverse scoring of the scales. Therefore, high scores indicate a positive attitude towards taking prophylactic asthma medication daily (Cronbach's $\alpha = 0.70$).

Negative attitude (con) was based on six statements on a 4-point scale (1 = 'strongly agree' to 4 = 'strongly disagree'). Participants were asked whether they agreed with statements regarding their asthma medication, such as "I don't always take my medicine because I don't want people to pity me". High scores indicate a less negative attitude towards taking medication (Cronbach's $\alpha = 0.67$).

Social influences was based on six statements on a 5-point scale (1 = 'totally disagree' to 5 = 'totally agree'). Participants were asked whether they agreed with statements regarding the opinion of four groups of important people in their environment with regard to taking asthma medication daily. An example of such a statement is: "My parents/carers think I should take my asthma medicine every day". High scores indicate a high degree of perceived social influence (Cronbach's $\alpha = 0.87$).

Self-efficacy directed towards the desired behaviour was based on four statements on a 4-point scale (1 = 'strongly disagree' to 4 = 'strongly agree'). Participants could indicate the probability of their ability to perform the desired behaviour with respect to asthma medication. This was intended to determine how participants evaluated their self-efficacy with regard to the desired behaviour. An example of such a statement is: "I always take my medication very carefully". High scores indicate positive expectations

of a participant to realise the desired behaviour with respect to asthma medication (Cronbach's $\alpha = 0.67$).

Self-efficacy aimed at overdosing was based on two statements on a 4-point scale (1 = 'strongly agree' to 4 = 'strongly disagree') to determine what patients think about taking more medication than prescribed by a physician. Participants could indicate the probability of their ability to refrain from taking more medication than prescribed by the physician. An example of such a statement is: "If I'm very short of breath, I take more medicine than my doctor told me to take". High scores indicate that the patient is not inclined to take more medication than prescribed by the physician (Cronbach's $\alpha = 0.71$).

Intention was assessed on the basis of one statement on a 7-point scale (1 = 'extremely unlikely' to 7 = 'extremely likely'). The statement: "I intend to take my asthma medicine every day" had to be scored by indicating the probability of this intention.

2.5. External factors

Apart from demographic data (sex, age and ethnic origin), the following external factors (psychological and medical determinants) were assessed.

Feeling ashamed about having asthma was based on a sub-scale of the 'Respiratory Illness Opinion Survey' (RIOS) [30,31], and consisted of seven questions on a 5-point scale (1 = 'never' to 5 = 'always') on the subject of feeling ashamed about having asthma. High sum-scores indicate that the participant is ashamed of having asthma (Cronbach's $\alpha = 0.62$).

To determine the *quality of communication with the physician as perceived by the patient*, a questionnaire was developed, partly based on the questionnaire developed by Richards et al. [32]. It also contained a question concerning the perceived quality of treatment provided by the physician and a question concerning the perceived empathic attitude of the physician. In total, the questionnaire consisted of 11 questions. A high score indicates that the participant had a positive perception of the quality of communication with the physician (Cronbach's $\alpha = 0.80$).

The extent to which asthma symptoms were severe enough to cause inconvenience to the patient during the previous 7 days [33] was assessed by asking the participant one question on a 5-point scale (1 = 'not at all bothered, no symptoms' to 5 = 'severely bothered, unable to function') about the inconvenience experienced during the previous 7 days. A high score indicates that the participant was severely bothered by asthma symptoms.

The severity of asthma, according to the physician [34] was based on the prescribed amount and type of medication, in the following categories: mild to moderate (stable with cromones); moderate to severe (stable with ≤ 400 μg inhaled corticosteroids per day); severe (>400 μg inhaled corticosteroids per day).

For the *frequency of prescribed dosage of daily prophylactic asthma medication*, the physician was asked to indicate how many times during the day the patient was instructed to take prophylactic medication according to the prescription.

2.6. Statistical analyses

A comparison was made of the baseline self-reported adherence, intention, demographic, and medical variables of participants whose self-reported adherence was available at T₁, and of participants who did not answer the question concerning self-reported adherence, withdrew from the study or no longer had to use prophylactic asthma medication at T₁ (defined as 'drop-outs'). For the first four variables, *t*-tests were performed. For variables which were scored on a nominal or ordinal scale, percentages are presented. For these variables χ^2 -tests and a Wilcoxon-test, respectively, were performed.

Linear regression analysis was applied to examine the relationship between self-reported adherence at 12 months follow-up (T₁) and its putative determinants at baseline (T₀). The regression models were also fitted for intention at T₁ as the dependent variable. To determine whether the ASE-variables explain any variation in self-reported adherence and intention, all ASE-variables were included in the linear regression models. External factors were only considered for inclusion in the model if they had a Pearson's correlation coefficient of at least 0.15 with self-reported adherence. Determinants were identified by means of backward elimination, with *P* = 0.10 as criterion, in order to retain potentially related variables. Initially, each individual component of the ASE-model (external factors, ASE-variables, and intention) was entered, independent of the other components, at first univariately, later multivariately, until the full ASE-model had been entered into the regression model. In order to adjust for the negligible effect of the intervention program, an indicator variable was forced into the regression model, and therefore, controlled for in the analyses.

3. Results

3.1. Description of the study population

Of the 165 eligible patients identified, 53 adolescents were unwilling to participate in the study, but were willing to make self-reports of their adherence. The mean self-reported adherence in this group was 7.5 (S.D. 1.6) which showed no statistically significant difference from that of the participants at baseline. The remaining 112 adolescents were willing to participate in the study. Between T₀ and T₁, 15 participants withdrew from the study. Reasons for withdrawal were: lack of time (*n* = 1), moved (*n* = 1), family circumstances (*n* = 2), moving to another hospital (*n* = 1),

Table 1

Baseline characteristics of participants and drop-outs^a

	Participants (<i>n</i> = 86)	Drop-outs (<i>n</i> = 26)	<i>P</i> -value
Self-reported adherence	7.5 (1.7)	6.8 (2.1)	0.12
Intention	6.0 (1.0)	5.5 (1.4)	0.09
Age	13.7 (1.3)	13.8 (1.3)	0.72
Duration of asthma	10.2 (3.5)	11.0 (3.8)	0.36
Sex (M/F)	36/47	19/7	0.01
Ethnic origin (caucasian/ non-caucasian)	65/19	19/6	0.89
Severity of asthma			
Mild to moderate	5	1	0.94
Moderate to severe	54	15	
Severe	27	8	

^a Baseline characteristics of participants and drop-outs on self-reported adherence, intention, demographic and medical variables. 'Drop-outs' were defined as participants who did not report their adherence at T₁, withdrew from the study or did no longer had to use prophylactic asthma medication at T₁. Mean values and S.D. are presented of the first four variables, for which *t*-tests were performed. For the other variables percentages are presented, as these variables were scored on a nominal or ordinal scale. For these variables χ^2 -tests and a Wilcoxon-test, respectively, were performed.

lack of motivation or no reason given (*n* = 10). Thus, 97 participants were available for further analysis at T₁. At 12 months follow-up (T₁) four participants no longer had to use prophylactic asthma medication, and were therefore, excluded from the analyses. Consequently, data of 86 participants concerning self-reported adherence were used for the analysis. Differences between participants who were still available at T₁ and drop-outs are presented in Table 1. There was one statistically significant difference between the groups. Drop-outs were more often of the male sex.

3.2. Determinants of adherence

At baseline the mean score for self-reported adherence was 7.5 (S.D. 1.7), and at 12 months follow-up it was 7.6 (S.D. 1.7).

Of the external factors, only the variable feeling ashamed about having asthma was correlated with self-reported adherence at T₁ (*r* = −0.16). This external factor was selected for further analyses. Although the randomised controlled trial was negative, in the sense that no differences between the intervention and usual care could be found, the type of intervention was always controlled for, in all regression models. The indicator variable for type of intervention was entered in a univariate regression model, and explained only 3% of the variance in self-reported adherence (Table 2) and 2% of the variance in intention (data not shown). In the univariate regression models, statistically significant associations were found between self-efficacy directed at the desired behaviour, intention and self-reported adherence at T₀, on the one hand, and self-reported adherence at T₁ as dependent variable on the other hand. The explained

Table 2
Results of univariate linear regression analyses with self-reported adherence at 12 months follow-up as dependent variable^a

	Self-reported adherence (<i>n</i> = 86)	
	<i>B</i> (<i>P</i>)	<i>R</i> ²
Type of intervention	−0.57 (0.11)	0.03
Intention	0.50 (0.00)	0.10
Self-reported adherence at T ₀	0.65 (0.00)	0.44
Attitude		
Pro	−0.08 (0.39)	0.01
Con	−0.12 (0.09)	0.04
Social influences		
Parents	−0.37 (0.33)	0.01
Peers	−0.02 (0.71)	0.00
Teachers	−0.25 (0.14)	0.03
Physician	−0.79 (0.15)	0.03
Self-efficacy		
Directed at desired behaviour	−0.22 (0.01)	0.09
Aimed at overdosing	−0.10 (0.39)	0.01
External factor		
Feeling ashamed		
About having asthma	−0.16 (0.00)	0.11

^a *B*: regression coefficient; range of self-reported adherence [1–10].

variance in self-reported adherence at T₁ varied for these determinants between 1 and 44% (Table 2).

The most important determinants of self-reported adherence at 12 months follow-up (T₁), adjusted for type of

intervention, were feeling ashamed about having asthma, a positive attitude to taking medication and intention. The external factor feeling ashamed about having asthma explained 17% of the variance in self-reported adherence (model 1), the ASE-variables 21% (model 2), and intention 11% (model 3). The percentage of explained variance of the full model was 23% of the variance in self-reported adherence (model 4). When self-reported previous behaviour was entered into the regression model, it appeared to be the strongest predictor of future behaviour. This variable explained 45% of the variance in self-reported adherence (model 5). After entering self-reported previous behaviour into the full model (model 6), statistically significant associations were found between feeling ashamed about having asthma, social influences (sub-scale: teachers), intention, self-reported adherence at T₀ and self-reported adherence at T₁. In this model, the explained variance in self-reported adherence was 53% (model 6; Table 3).

The ASE-model postulates that intention predicts behaviour. Therefore, the most important determinants of intention were also identified by means of multiple regression analysis. Statistically significant associations were found between feeling ashamed about having asthma, a positive attitude to taking medication, self-efficacy directed toward the desired behaviour, and intention at T₀, on the one hand, and intention at T₁ as dependent variable on the other hand. The explained variance in intention varied between 4 and 24% (data not shown).

Table 3
Results of multiple linear regression analyses with self-reported adherence at 12 months follow-up as dependent variable^a

	Self-reported adherence (<i>n</i> = 86)					
	Model 1 <i>B</i> (<i>P</i>)	Model 2 <i>B</i> (<i>P</i>)	Model 3 <i>B</i> (<i>P</i>)	Model 4 <i>B</i> (<i>P</i>)	Model 5 <i>B</i> (<i>P</i>)	Model 6 <i>B</i> (<i>P</i>)
Correction for type of intervention	−0.77 (0.03)	−0.31 (0.36)	−0.35 (0.33)	−0.55 (0.10)	−0.35 (0.20)	−0.49 (0.07)
Intention			0.46 (0.01)	0.52 (0.00)		
Self-reported adherence at T ₀					0.64 (0.00)	0.55 (0.00)
Attitude						
Pro				−0.24 (0.01)		
Con						
Social influences						
Parents						
Peers		0.18 (0.10)				
Teachers		−1.00 (0.06)				
Physician		−0.65 (0.03)				−0.74 (0.06)
Self-efficacy						
Directed at desired behaviour		−0.29 (0.00)				
Aimed at overdosing						
External factor						
Feeling ashamed	−0.18 (0.00)			−0.17 (0.00)		−0.15 (0.00)
About having asthma						
<i>R</i> ²	0.17	0.21	0.11	0.23	0.45	0.53

^a *B*: regression coefficient; range of self-reported adherence [1–10]. The different regression models 1 up to and including 6 are presented in an increasing sequence from left to right. These final regression models were obtained by employing a backward variable reduction technique (*P* = 0.10), participation in the intervention program was always controlled for in all regression models.

4. Discussion

The ASE-model was used in the present study to explain self-reported adherence to asthma medication 1 year later, by investigating the long-term influence of cognitive variables reported at T_0 . The results of the multiple regression analyses showed that the three major ASE-variables were predictors of self-reported adherence to a moderate degree. Previous self-reported adherence was found to be the best predictor of self-reported adherence to prophylactic asthma medication 1 year later.

Ajzen's suggestion [28] that previous behaviour makes no significant unique contribution to predicting behaviour after controlling for attitude, social influences, self-efficacy and intention, is not supported by the findings of this study. The results are more in accordance with the findings of Lechner et al. [35] and de Vries et al. [16]. In the study carried out by Lechner et al. [35], it was found that previous behaviour with regard to breast cancer screening was one of the most important determinants of behavioural intentions and of participation in the second breast screening cycle. De Vries et al. [16] found that previous behaviour was the strongest predictor of future smoking behaviour. Triandlis [36] stated that as behaviour takes place repeatedly, habit increases and becomes a better predictor of behaviour than behavioural intentions. To some extent, this frequently repeated behaviour occurs habitually, without the mediation of attitudes, social influences, self-efficacy and intention. This also implies that a person might be less aware of the influence of cognitive variables on the occurrence of this behaviour, and therefore, behaves in an accustomed way without making a conscious decision to act. As a result, this behaviour may be less clearly predicted by cognitive variables [36]. To account for this effect, habit should be included in the analyses. This is usually done by operationalising habit as previous behaviour. Self-reported adherence to prophylactic asthma medication 1 year later appeared to be most clearly predicted by self-reported previous behaviour. This may indicate that adherence to prophylactic asthma medication can be considered as a habit, and should be treated as a habit if the intention is to enhance adherence. Healthy habits are quite difficult to establish, and once unhealthy habits have been formed, they are hard to break [37]. Therefore, healthy habits should be established as soon as possible if unhealthy habits are to be prevented.

The present study has some possible limitations. It was not primarily designed as a cohort study, but as a randomised controlled trial. The intervention, however, appeared to have had no effect on adherence to prophylactic asthma medication, and participation in the intervention program was controlled for in the analyses. It was not possible to compare the adolescents who participated in the study with those who refused to participate, and it is conceivable that there may be differences on other relevant characteristics. A major limitation of this study pertains to the relatively high percentage of drop-outs and the difference between the participants and

the drop-outs. Comparing baseline self-reported adherence, intention, demographic and medical characteristics of participants and drop-outs showed one statistically significant difference between these two groups. Drop-outs were more often of the male sex. One other shortcoming of this study might involve the limited operationalisation of the ASE-concepts. Finally, another possible limitation concerns the use of self-report as method to assess adherence. As has been stated by Berry et al. [38], this method of assessing adherence is probably not related in any one-to-one way to actual adherence behaviour. Ley [3], however, after reviewing the different methods for assessing adherence, stated that the most popular method, i.e. patient reports, correlates significantly with other methods of measurement. The opinion of DiMatteo and DiNicola [39] is that one should seek to understand the reporting of adherence by patients, just as one seeks to understand adherence behaviour itself. It should, therefore, be emphasised that the lack of existence of a feasible method for the assessment of adherence is still one of the drawbacks faced in any study concerning adherence to inhaled asthma medication. It is important that future studies on adherence make use of reliable and valid electronic devices. However, these methods are also open to criticism.

5. Conclusion

The general conclusion is that the ASE-model provides some insight into the factors influencing adherence to asthma medication. Haynes et al. [40] stated that to achieve the full benefits of current medical therapies, we need a better understanding of adherence. Unfortunately, most strategies to enhance adherence with long-term medication prescription, studied before 1997, have not been very effective. Trials concerning adherence interventions provide little evidence that adherence can be improved consistently [40].

5.1. Impracticable implication

Haynes et al. [40] stated that effective ways to help people adhere to medical treatment would have far greater effects on health than any treatment itself. The results of the present study could be useful in the development of interventions of this kind. Future interventions to enhance adherence to asthma medication should certainly focus on feelings of shame about having asthma and establishing healthy habits, such as adherence [37]. In general, healthy habits should be established as soon as possible, to prevent unhealthy habits being formed.

Acknowledgements

We would like to thank the patients and paediatricians (O.H. van der Baan-Slootweg, J.E. Dankert-Roelse, Ph.D., E.E.M. van Essen-Zandvliet, Ph.D., R.W. Griffioen, A.G.

Ketel, C.E. van Marle, A.F. Nagelkerke, J.C. van Nierop, J.G.M. Rijntjes, R.J. Roorda, Ph.D., M.A.C. Slee and H. Verweij) for their contribution. We also thank H. de Vries, Ph.D. for his advice concerning the ASE-model and Faith Maddever for corrections in the English text.

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